SNI

Standar Nasional Indonesia

SNI 1452-2007

# Steel cylinder for LPG

ICS 43.040.60

Badan Standardisasi Nasional

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# List Of Content

## Foreword

This Standar Nasional Indonesia (SNI) standard *Tabung baja LPG* is a revised edition of SNI 19-1452-2006, the sections revised include classification, materials specifications, construction, steel cylinder manufacturing, quality requirements, sampling and test methods.

This standard was developed and prepared based on the following considerations:

- To develop a conducive and fair competitive business climate and to ensure consumers protection
- With the development of the societal life pattern and catering consumers interest at the moment, the consumers demand the availability of different types of LPG cylinders with better safety attributes
- To satisfy these demands the existing SNI needs revision

Therefore, it is expected that the interpretation in existence at this moment can be improved implementing this standard, and in this way the quality level and production efficiency increased, cost saving obtained, quality assurance for consumers and producers secured, and thereby achieve a conducive competitive atmosphere and a sound support for the development program of interrelated sectors.

This standard was deliberated in a consensus meeting held in Jakarta on December 4$^{th}$ 2006; which was attended by members of the Technical Committee, representatives of manufactures, consumers, universities, research institutes and other related stakeholders.

This standard was developed and prepared by the Technical Committee (77-01), Metals, Iron and Steel Products.

# Steel cylinder for LPG

## 1. Scope

This standard specifies the design and construction, size and test methods for LPG steel cylinders of 3 kg capacity up to and including 50 kg capacity type.

## 2. Normative references

SNI 07-0410-1989, *Cara uji lengkung tekan logam.*

SNI 07-0408-1989, *Cara uji tarik logam*

SNI 07-0722-1989, *Baja karbon canai panas untuk konstruksi umum*

SNI 07-3018-2006**,** *Baja pelat, strip dan lembaran canai panas untuk tabung gas*

SNI 05-3565-1994, *Bejana tekan 1-A*

ISO 22991:2004, *Gas cylinders – Transportable refillable welded steel cylinder for liquefied petroleum gas (LPG) – Design and construction*

JIS G 3116-2000, *Steel sheet, plate and strip for gas cylinders*

JIS G 4051-1979, *Carbon steel for machine structural use*

JIS G 3101: *Rolled steel for general structures*

AS 2469-1998, *Steel cylinders for compressed gases-welded two-piece construction – 01 kg to 35 kg*

AS 2470-1998, *Steel cylinders for compressed gases-welded three-piece construction – 11 kg to 150 kg*

## 3 Terms and definitions

### 3.1

### LPG steel cylinder

steel cylinder constructed from hot rolled carbon steel plates and used for storing LPG (liquefied petroleum gas) with a filling capacity of 3 kg (7,3 liters) up to and including 50 kg (108 liters) with a designed compression pressure of minimum 18.6 $kg/cm^2$

## 4 Classification

LPG steel cylinders are classified into:

a) two-piece construction: 3 kg up to and including maximum 15 kg capacity

b) three-piece construction: over 15 kg up to and including maximum 50 kg capacity

## 5 Materials specifications

### 5.1 Cylinder body

The materials for the cylinder body shall either conform to SNI 07-3018-2006, *Baja lembaran pelat dan gulungan canai panas untuk tabung gas (Bj TG)* or to JIS G 3116, grade SG 26 (Sg 255), SG 30 (SG 295),

### 5.2 Neck ring

Materials for the neck ring shall conform to JIS G 4051 grade S17C up to and including S45C

### 5.3 Foot ring and hand guard

Materials for foot ring and hand guard shall conform to SNI 07-0722-1989, *Baja canai panas untuk konstruksi umum,* JIS G 3101, grade SS400 or other materials compatible to the respective cylinder body.

## 6 Construction

### 6.1 General construction

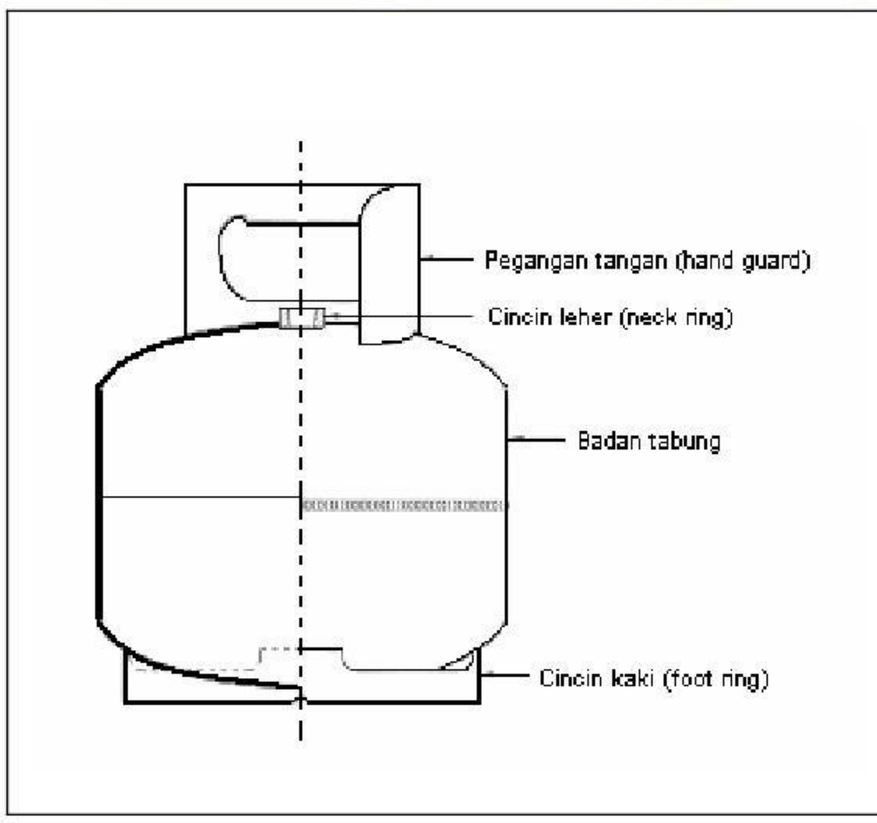
The cylinder consists of:

a. Cylinder body constituted of top and bottom part for the 2 (two)-piece construction and for the 3 (three)-piece construction constituted of top, middle and bottom part.

b. Neck ring

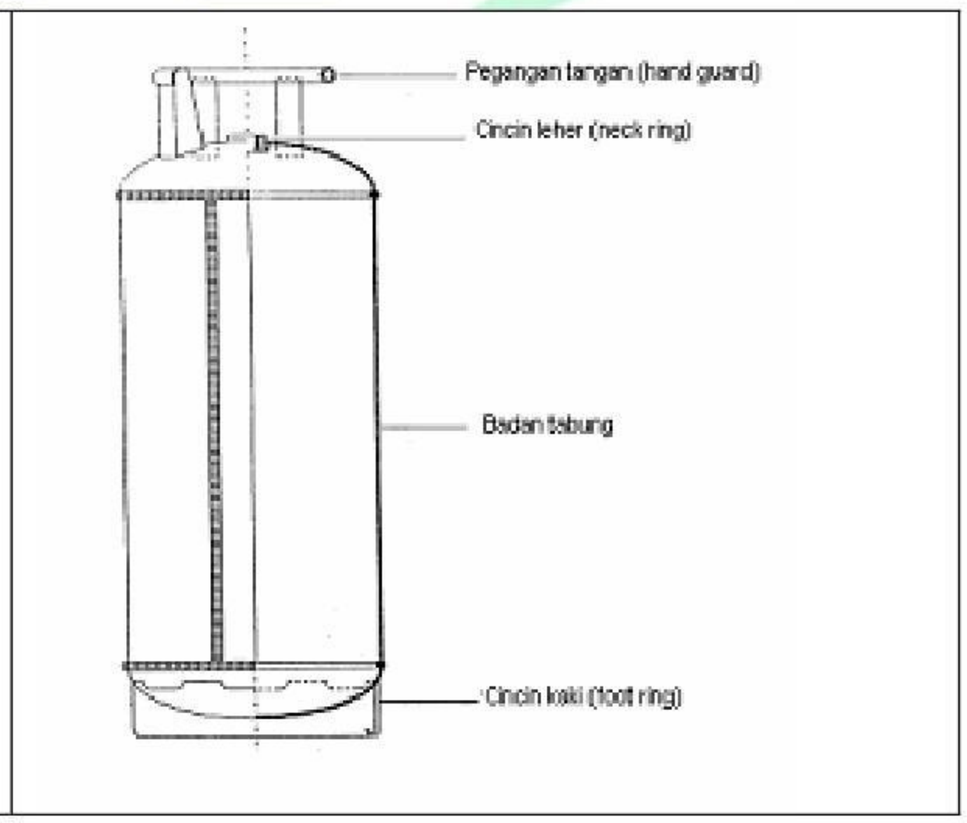
c. Hand guard

d. Foot ring




Hand guard
Neck ring
Cylinder body
Foot ring

**Figure 1 a** Drawing of parts of a two-piece cylinder




Hand guard
Neck ring
Cylinder body
Foot ring

**Figure 1 b** Drawing of parts of a three-piece cylinder

## 6.2 Minimum thickness determination of cylinder body

### 6.2.1 2 (two)- piece constructed cylinder

The wall thickness is calculated using the equations (AS 2469 -1998) as follows:

$$t = 2{,}5 \left( \frac{D_i}{R_m} \right)^{1/2} \quad \text{..... .1)}$$

and

$$t = \left( \frac{P_h \text{ x. } D_o}{2f + P_h} \right) \quad \text{..... 2)}$$

$$t \text{ minimum} = t + CA \quad \text{.....3)}$$

where:

t is the minimum thickness of the cylinder body (mm); taken from the largest calculated value using equation 1 or 2;

$D_1$ is the internal diameter of the cylinder (mm);

$D_0$ is the outer diameter of the cylinder (mm);

$P_h$ is the test pressure (MPa);

f is the maximum permissible stress, equal to 90% x Yield Strength of cylinder material, if the f value of the yield strength is greater than 60% of the tensile strength ($R_m$), then the f value to be applied is 60 % $R_m$

$R_m$ is the minimum tensile strength (MPa);

CA is the Corrosion Allowance, the value of which is 0,01 mm per year and assuming a calculated lifetime of 5 years.

### 6.2.2 3 (three)- piece constructed cylinder

$$t = 2{,}5 \left( \frac{D_i}{R_m} \right)^{1/2} \quad \text{..... 4)}$$

and

$$t = \left( \frac{P_h \text{ x . } D_o}{2f\eta + Ph} \right) \text{ ..... 5)}$$

$$t \text{ minimum } = t + CA \text{ .....6)}$$

where:

t is the minimum thickness of the cylinder body (mm); taken from the largest calculated value using equation 4 or 5;

$t_m$ is the minimum calculated thickness;

$D_1$ is the internal diameter of the cylinder (mm);

$D_0$ is the outer diameter of the cylinder (mm);

$P_h$ is the test pressure (MPa);

f is the maximal permissible stress, equal to 90% x Yield Strength of cylinder material used, if the f value of the yield strength is greater than 60% of the tensile strength ($R_m$), then the f value to be applied is 60 % $R_m$

η efficiency of weld joint;

= 0.90, radiography test is taken by sampling

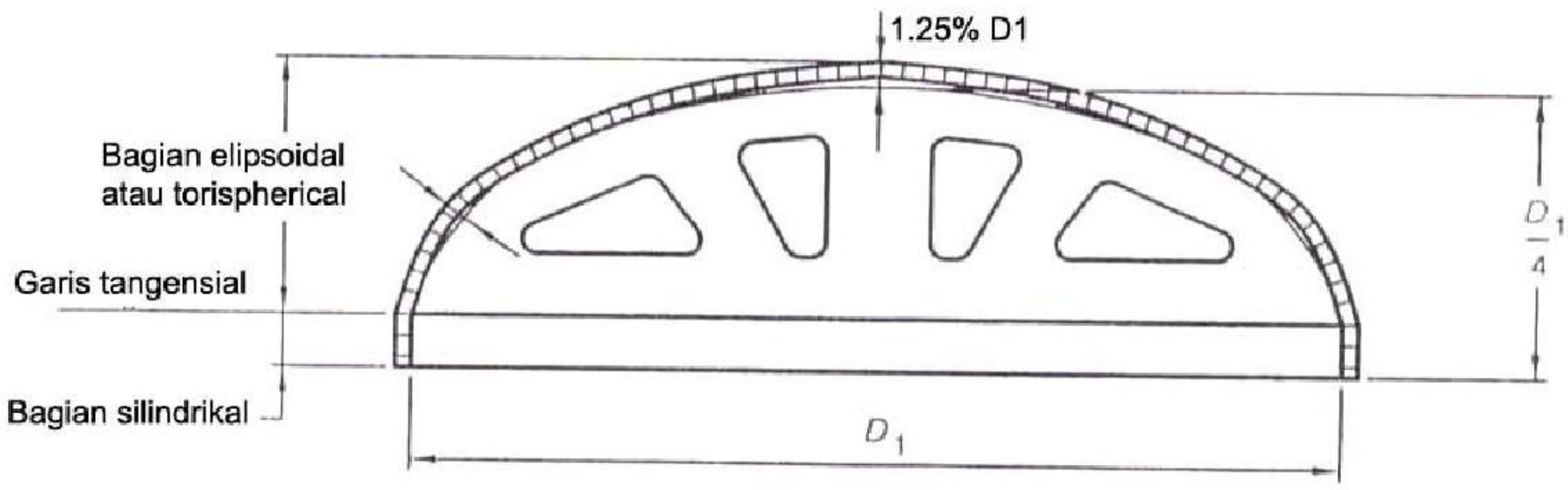
$R_m$ minimum tensile strength *(*MPa);

CA is the Corrosion Allowance, the value of which is 0,01 mm per year and assuming a calculated lifetime of 5 years.

### 6.3 Curvature of cylinder body section

The top and bottom of the cylinder body is ellipsoidal or torispherical in shape. The ellipsoidal shape has a maximum ratio of 2 : 1 with respect to the inner diameter of the cylinder. Example: the internal height of the sphere is 25% of the internal diameter of the cylinder.

Deviation of the shape when measured perpendicular to the surface of the pressing process result with respect of the ellipsoidal pattern shall not exceed 1,25% of the outer diameter of the cylinder.




Ellipsoidal or torisherical part

Tangential line

Cylindrical part

Figure note:

D1 is the internal diameter of the cylinder

**Figure 2 Sample of an ellipsoidal pattern with 2 : 1 ratio**

### 6.4 Foot ring

The foot ring shall be able to support the cylinder solidly and take a vertical position, and the foot ring shape shall not cause water trapping.

## 6.5 Hand guard

The hand guard shall be able to protect the valve in case of collision and shall be able to support the weight and content of the cylinder during lifting.

## 6.6 Neck ring

The flange shaped neck ring is to securely attach the valve

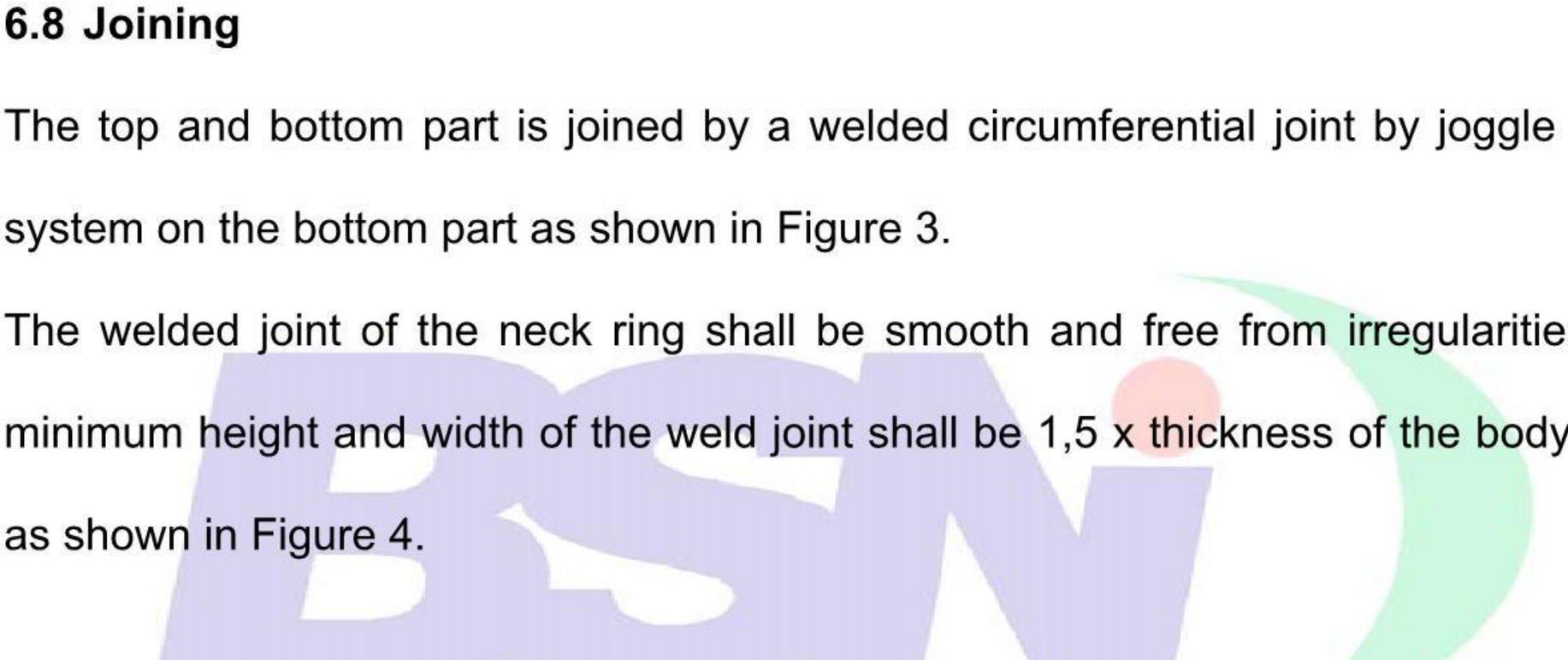
## 6.7 Cylinder height

The height of a 2 (two)-piece cylinder shall not exceed 4 x the cylinder body diameter

## 6.8 Joining

The top and bottom part is joined by a welded circumferential joint by joggle offset system on the bottom part as shown in Figure 3.

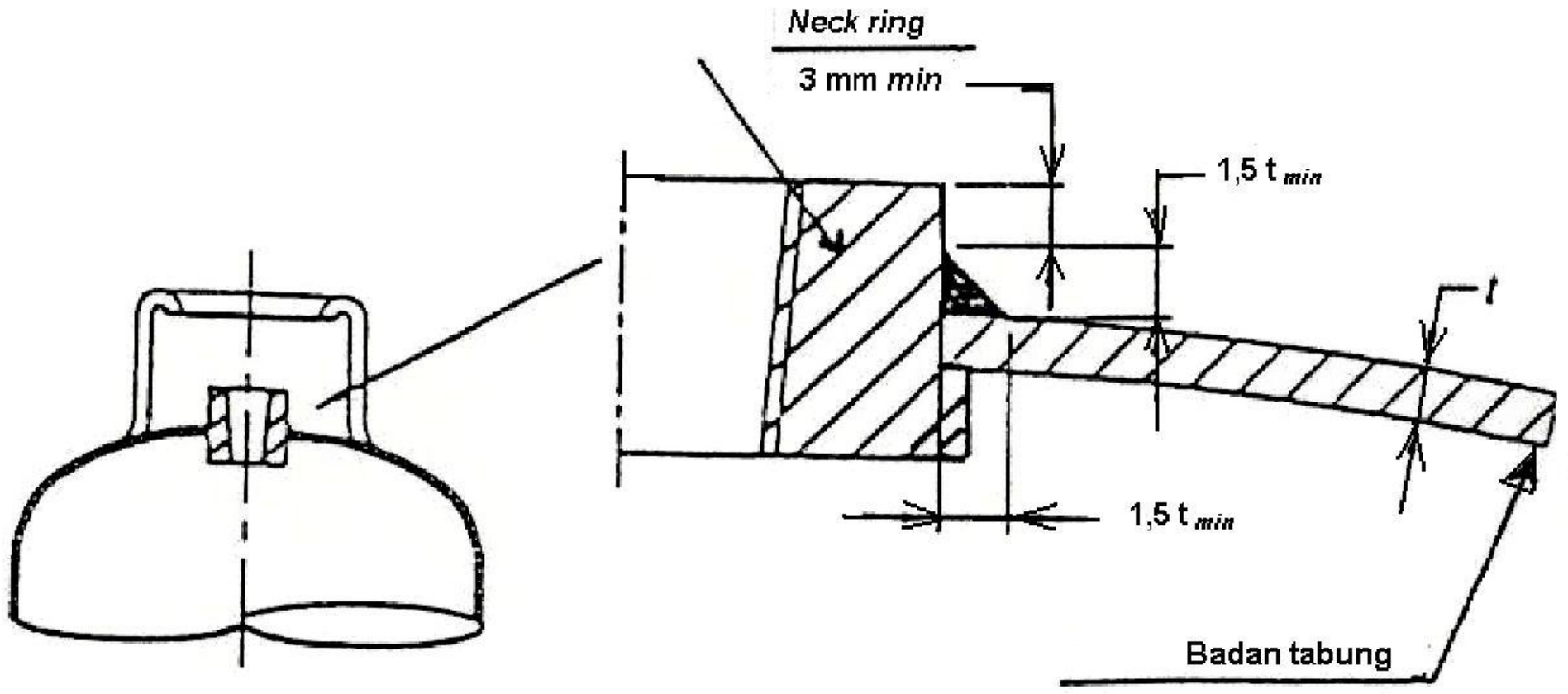
The welded joint of the neck ring shall be smooth and free from irregularities, the minimum height and width of the weld joint shall be 1,5 x thickness of the body plate as shown in Figure 4.




$2,5\ t_{max}$
$t_{min}$
t = nominal

Avoid a notch at this position

**Figure 3 Circumferential weld joint profile**




Cylinder body

**Figure 4 Neck ring weld joint profile**

## 7 Cylinder manufacturing method

**7.1** The hot rolled steel plate is cut to the size required and lubricated before the press forming process.

**7.2** Forming is carried out by deep drawing, producing the top and bottom part of the cylinder body

**7.3** An opening is made in the top part of the cylinder to attach the neck ring.

**7.4** The neck ring is secured by a gas metal arc weld joint.

**7.5** The top and bottom part circumferential joint and the longitudinal joint of the middle part of cylinder type 15 kg up to including 50 kg is done by submerged arc welding. While the weld joint between top and bottom part of the cylinder is a lap joint.

**7.6** The weld joint of the hand guard and foot ring to the cylinder body is a fillet weld and is done by shielded metal arc welding.

**7.7** Welding in 7.4, 7.5 and 7.6 shall be carried out by a competent qualified welders or welding operators.

**7.8** Each cylinder shall be annealed, at a temperature of 630 $^{o}$C ± 25 $^{o}$C for at least 20 minutes to relieve the residual stresses.

**7.9** To prevent corrosion at the outer surface of the cylinder, the cylinder surface shall be protected by painting. Before painting the whole cylinder surface shall be cleaned by shot blasting. The first paint layer consist of a primer coat with a thickness of 25 micron up to 30 micron followed by a top coat with a thickness of 25 micron up to 30 micron.

## 8 Quality requirements

### 8.1 Appearance

The surface of each LPG steel cylinder shall be free from defects or manufacturing irregularities such as: scratches, dents and shape distortions that can reduce the strength and safety in use.

### 8.2 Dimension

#### 8.2.1 Cylinder circumference

Out of roundness or difference between the maximum and minimal diameter at the cylindrical section of the cylinder shall be: 1% for a 2 - piece cylinder and 1,5% for a 3 - piece cylinder.

#### 8.2.2 Straightness

The vertical deviation shall not exceed 25 mm per meter

### 8.3 Hydrostatic endurance

Each cylinder shall withstand a hydrostatic pressure of 31 kg/cm$^2$ and at that pressure no water leakage or leaking shall be detected and no change in shape shall take place.

### 8.4 Air tightness test

A cylinder with a valve in place shall be air tight / no leakage shall be observed at an air pressure of 18,6 kg/cm$^2$.

### 8.5 Burst strength

The cylinder shall be hydrostatically tested until collapse occurs. The pressure at fracture shall not be less than 110 kg/cm$^2$ for cylinder type 3 kg up to 15 kg, and shall not be less than 80 kg/cm$^2$ for cylinder type over 15 kg up to 50 kg. The fracture of the cylinder shall not initiate in a weld joint.

### 8.6 Permanent volumetric expansion endurance

The cylinder shall be hydrostatically tested at a pressure of 31 kg/cm$^2$ for 30 seconds. The permanent volumetric expansion shall not exceed 1/5000 of the initial volume. No leakage shall be observed and no shape deformation shall occur.

### 8.7 Weld joint

The weld joint shall be smooth, free from irregularities, and no weld defects shall occur as to reduce the strength in use. The weld joint size is shown in Figure 3. Mechanical testing include tensile testing of weld joints and its value shall be at least the same or exceeding the tensile strength of the parent material used and its fracture shall not initiate in a weld joint. The radiographic specification shall conform to SNI 05-3563-1994, *Bejana tekan 1-A, Bab BL Persyaratan bejana tekan yang difabrikasi dengan pengelasan, BL-51.b.*

## 8.8 Painting

The paint layer shall be subjected and conform to the paint layer test as specified in 10.8

# 9 Sampling

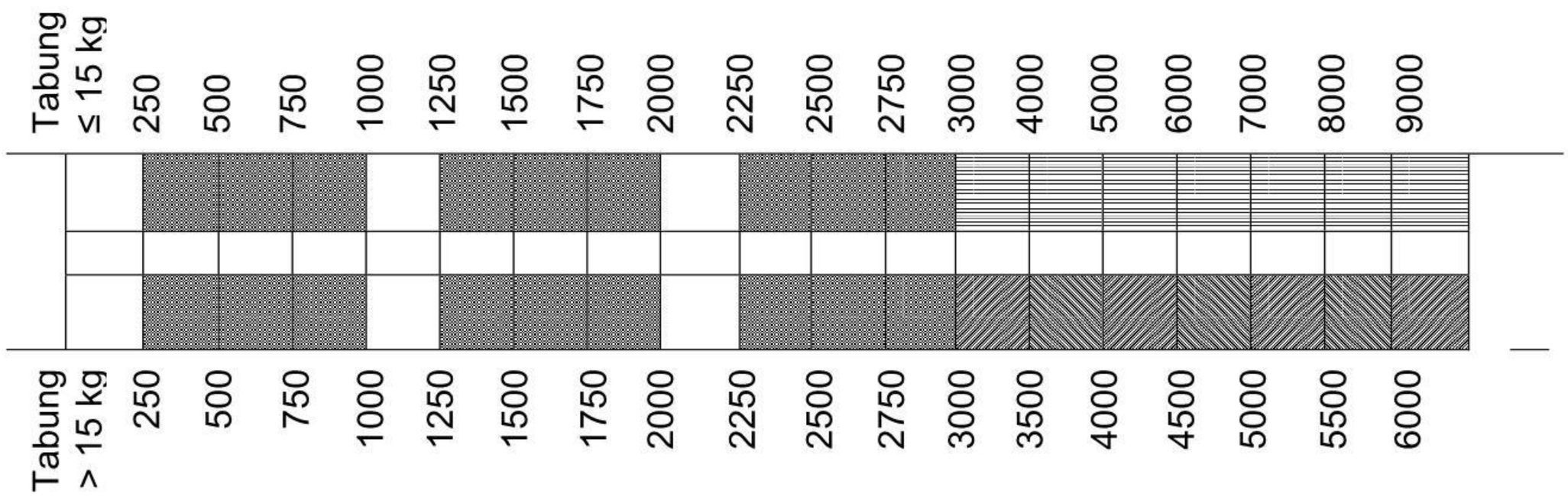
**9.1** For routine testing purposes carried out by the manufacturer, sampling shall be as follows:

a) Each cylinder shall be tested as specified in 8.1, 8.2 and 8.3.

b) From each group of the same type and size consisting of up to 500 cylinders 1 (one) sample shall be taken at random for radiographic examination purposes. Exception, for type “3 - piece construction” up to 250 cylinders 1 sample shall be taken at random.
Radiography samples, 150 mm in length shall be taken from the longitudinal weld end and 50 mm in length taken from each circumferential weld intersection side end.

c) Mechanical testing and burst test shall be carried out according to Table 1 (ISO 22991:2004) as follows:

**Table 1 Sampling**




| Number of lot/ sub lot | Symbol | Total number of cylinders | Test method |
|---|---|---|---|
| | | | |
| 250 | | 2 | 1 for burst test 1 for mechanical test |
| | | | |
| 250 | | 1 | 1 for mechanical test or burst test |
| | | | |
| 500 | | 2 | 1 for burst test and 1 for mechanical test |
| | | | |
| 500 | | 1 | 1 mechanical test or burst test |
| | | | |
| 1000 | | 2 | 1 for burst test and 1 for mechanical test |
| | | | |

**9.2** For inspection and representative testing of 3 sample cylinders, sampling is done at random for each type by a competent and authorized personnel based on valid regulations.

## 10 Test method

### 10.1 Appearance test

This test is done visually without the aid of a magnifying glass and the test results shall conform to 8.1

### 10.2 Dimension

Measurement of cylinder circumference (8.2.1) and straightness (8.2.2) is carried out using a measuring device with an accuracy of 0,5 mm.

### 10.3 Hydrostatic strength test

The cylinder is filled / pressed with water with a pressure of 31 kg/cm$^2$ and the test results shall conform to 8.3

### 10.4 Air tightness test

The cylinder with a valve attached, is pressurized with air at the pressure of 18,6 kg/cm$^2$ and immersed in water and shall not reveal any leakage, by releasing air bulbs in the water.

### 10.5 Burst test

The cylinder is filled/pressurized with water until rupture occurs, the test result shall conform to 8.5

### 10.6 Permanent volume expansion test

The cylinder is filled with water at a pressure of 31 kg/cm$^2$ for at least 30 seconds. The permanent volume expansion is then measured by calculating the difference between the volume at the start and at the end of the test. The test results shall conform to 8.6

### 10.7 Weld joint test

Mechanical test shall in be carried out in accordance with SNI 07-0408-1989, *Cara uji tarik logam* and SNI 07-0410-1989, *Cara uji lengkung tekan logam.* Radiography test shall be carried out in accordance with existing regulation and shall conform with SNI 05-3563-1994, *Bejana tekan 1-A, Bab BL Persyaratan bejana tekan yang difabrikasi dengan pengelasan, BL-51.b*

## 10.8 Painted layer test

Corrosion resistance test

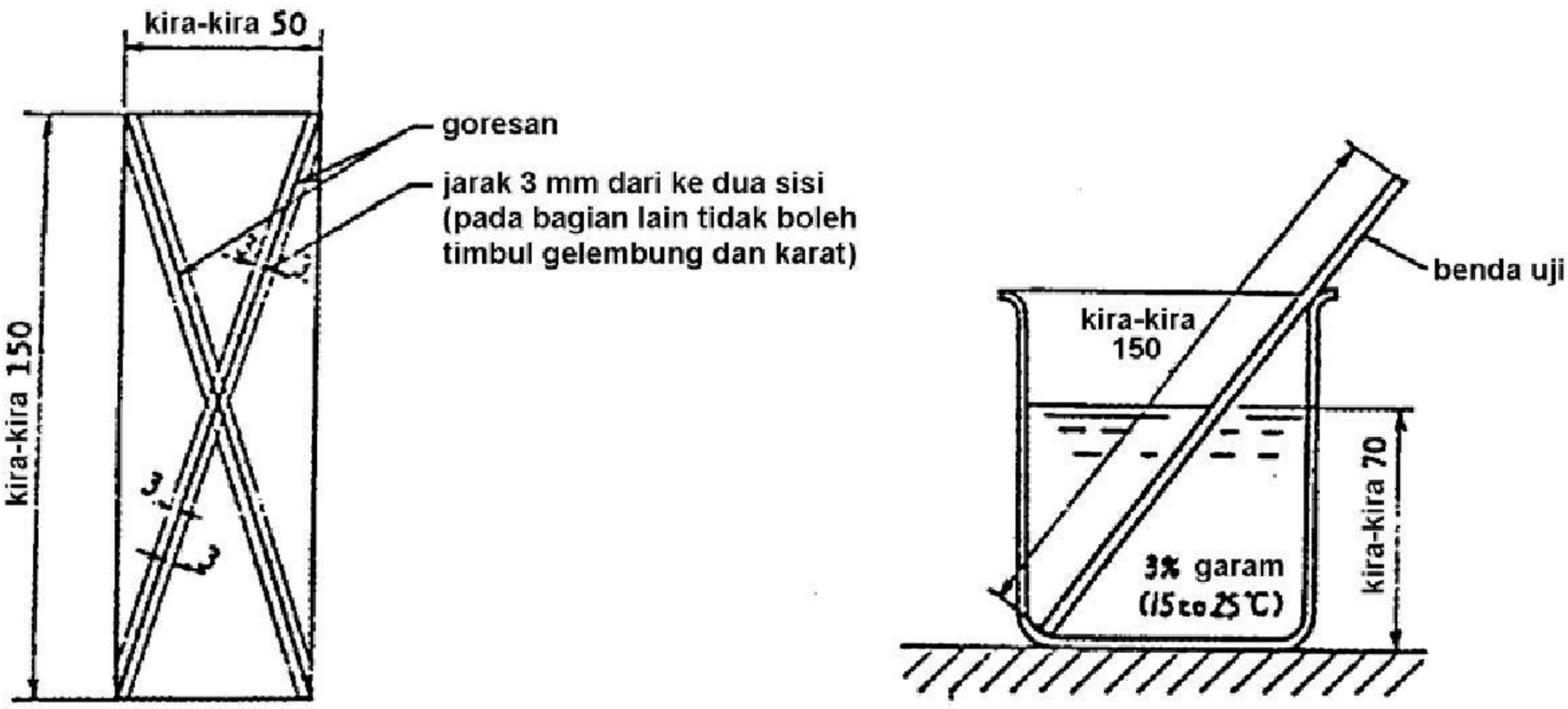
This test should be carried out using one of the test samples as shown below

a) Prepare a steel plate sample from the parent material used for the cylinder measuring about 150 mm in length, 50 mm wide and painted in accordance with 8.8

b) A cylinder can also be used as sample by using the following test procedures

The test sequence is as follows:

The test sample is scratched with a sharp knife at both its sides as shown in Figure 5, the sample is then immersed in a flask containing a 3% salt solution (NaCl) (at a temperature between15 °C to 25 °C). The immersion depth is about 70 mm from the scratch edge, and immerse for 100 hours. Watch the release of gas bubbles at a 3 mm distance from both sides of the scratch and then after lifting, wash with water and dry. No rust shall appear at a distance exceeding 3 mm from both sides of the scratch (see Figure 5)




Keterangan gambar

Kira-kira 50 approximately 50
Kira-kira 150 approximately 150
Goresan scratch
Jarak 3 mm dari ke dua sisi
(pada bagian lain tidak boleh
timbul gelembung dan karat)
At a distance of 3 mm from both sides
(At other sections no bubbles and rust may
form)
benda uji test piece

Satuan dalam millimeter

Units in millimeters
benda uji test piece
kira-kira 150 approximately 150
kira-kira 70 approximately 70
3% garam 3% salt solution
15°C – 25°C

**Figure 5 Corrosion prevention test**

## 11 Acceptance requirements

**11.1** The sample in accordance with 9.1 is accepted whenever conforming to the requirements as specified in 8. When any requirement is not fulfilled, the cylinder is rejected

**11.2** A test sample taken according to the sampling method in 9.2 is accepted when all the requirements in 8 are fulfilled, in this way the group represented by the sample is accepted.

When the sample failed any requirement specified in 8, the sample shall be rejected and the group represented by the sample shall also be rejected and a retest shall be permitted.

**11.3** Retest shall be carried out on a group that failed to meet the specified requirements using 2 (twice) the number of samples used in the first test. If any specimen fails to meet a specified requirement in accordance with 8, the group it represents is rejected.

## 12 Marking

Each cylinder that is accepted shall be legibly identified with embossed/stamped markings at least indicating:

- Identity/marking/logo of the manufacturer
- Production number
- Empty mass of cylinder
- Month and year of production
- Test pressure
- Water capacity
- Red circle at neck ring

## Bibliography

ASME Code Section IX, *Welding and Brazing Qualification (see SNI)*

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